ACID PRECIPITATION IN ONTARIO STUDY

THE EFFECTS OF ACID PRECIPITATION ON RECREATION AND TOURISM IN ONTARIO

VOLUME 1

PREPARED FOR
THE ONTARIO MINISTRY OF THE ENVIRONMENT
BY

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in association with

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Management Consultants

Currie, Coopers & Lybrand Ltd.

ONTARIO MINISTRY OF THE ENVIRONMENT

THE EFFECTS OF ACIDIC PRECIPITATION ON RECREATION AND TOURISM IN ONTARIO - Volume I

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EXECUTIVE SUMMARY

The major purpose of this report is to start to develop an understanding of the effects of acidic precipitation on recreation and tourism in Ontario. This report is one of a series of studies which are intended to provide information that will help in determining the appropriate level of pollution abatement.

Links can be established between acidic precipitation and key recreation and tourism resources. At present the key identified links are through the aquatic environment. Activities that are or have the potential to be effected are fishing, waterfowl and moose hunting and water contact activities such as swimming and boating. Of these activities, current research can only establish definite links with fishing and potential indirect links with waterfowl and moose hunting. Large sections of Ontario have aquatic environments that have the physical characteristics to be sensitive to acidification.

Aquatic-based activities are a key component of recreation and tourism in the potentially sensitive parts of Ontario. Activities such as fishing, swimming and boating, are very popular among residents and attract many non-residents to the province. As a result of their popularity, these activities generate an estimated $450 million of direct expenditures annually in the potentially sensitive parts of Ontario. This level of annual expenditure accounts for an estimated 6-9% of total direct tourist expenditures in the province.

At the present time only small parts of Ontario are considered to be acidified. Thus the extent of current physical damages is limited. In addition, we are only able to quantify the effects of acidification on fish reproductive capability. Links to other types of effects on fish and other types of aquatic-based activities have not been quantified in this study.

The economic implications of the current levels of quantifiable damage measured on the basis of changes in expenditure are not extensive and

relate primarily to localized reductions in fishing activity. This approach significantly underestimates the total value of damage. It is likely that the fear factor for an, as yet, unproved effect, could be having a larger impact than actual physical damage. With the continuation of negative publicity the extent of these damages could increase significantly with large portions of Ontario experiencing widespread economic effects.

It must be stressed that the conclusions reached in this report are preliminary and much additional research needs to be undertaken before definitive conclusions can be drawn. This report is intended to be a first step in analyzing the complex implications for recreation and tourism of acidic precipitation. As such, this report has not reached definite conclusions on all aspects of the problem and the evaluation is thus incomplete. This should be recognized in the use of damage estimates developed in this report. However, this report does indicate that acidic precipitation has a potential economic impact of significance and it therefore provides the basis for action to address many of the unknown effects which are of concern.

I. INTRODUCTION

In the summer of 1980, Currie, Coopers & Lybrand Ltd., in association with Earl R. Combs Inc. and Larry Smith & Associates Ltd., was retained by the Ontario Ministry of the Environment to develop a framework for, and to undertake an assessment of, the economic implications of acidic precipitation for tourism and recreation in Ontario. This study of the impact of acidic precipitation on recreation and tourism is one in a series of studies which "are intended to produce information that can be used to make decisions about appropriate management strategies to resolve the problems caused by acid precipitation. Most particularly, these investigations will help to provide information needed to determine an economically rational level of pollution reduction."[1]

Tourism and recreation have been identified as areas of special interest because much of Ontario's prime outdoor recreation and tourism area is believed to be susceptible to the effects of acidic precipitation.

This report represents a start to developing a comprehensive understanding of the implications of acidic precipitation for the economy of Ontario. The report's scope, purpose, and approach are outlined below.

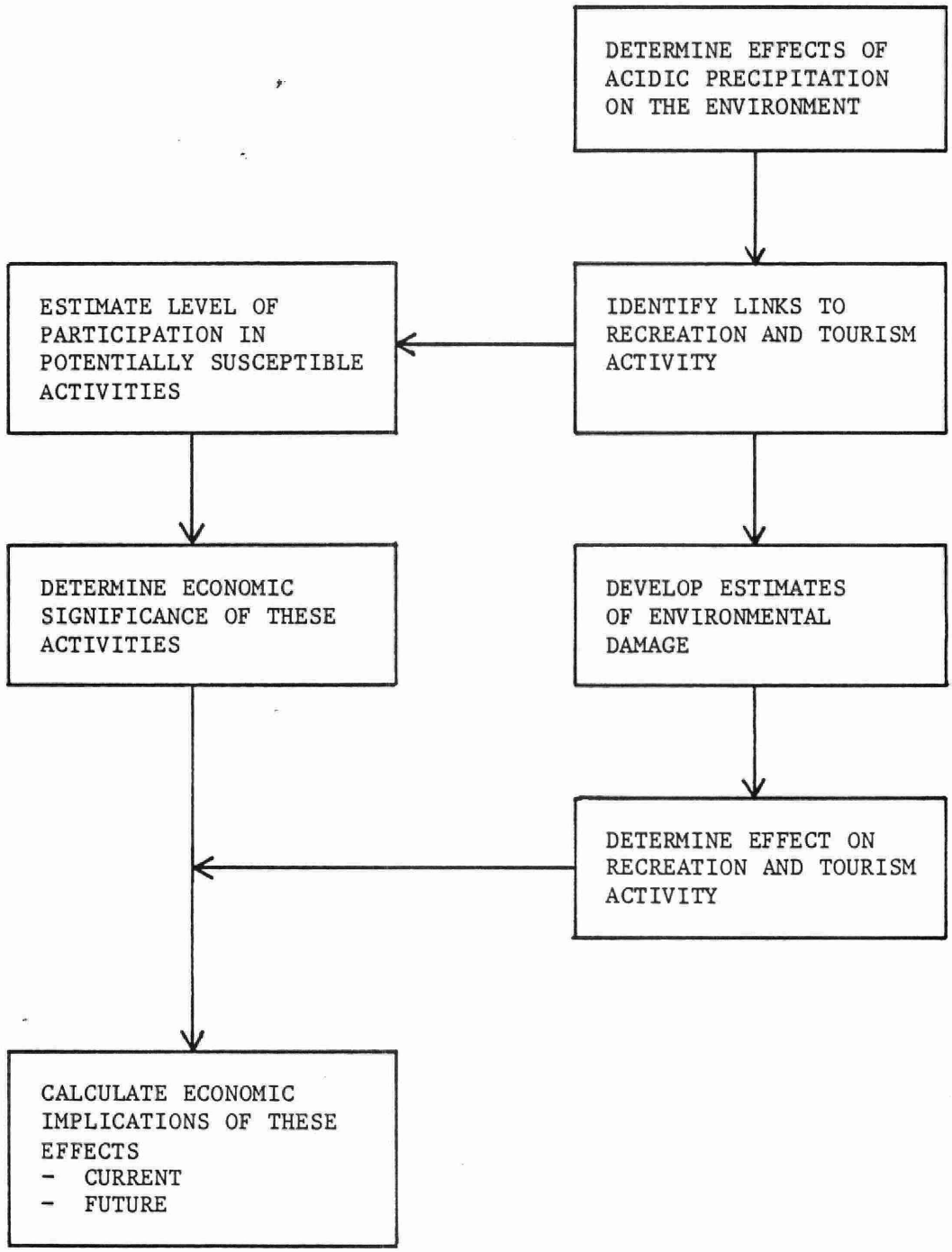
A. THE SCOPE AND PURPOSE

The main purpose of this report has been to develop a framework for analyzing the effects of acidification of the aquatic environment on tourism and recreation. To accomplish this task, this study has focused on five major areas of interest, including:

1. Identifying the likely links between acidic precipitation and recreation and tourism in Ontario.
2. Estimating the economic significance of aquatic-based recreation and tourism.
3. Describing the current and possible future effects of acid precipitation.
4. Estimating the implications of these effects for the tourism and recreation sector of the Ontario economy.
5. Identifying the key requirements for additional research.

EXHIBIT 1

ANALYTICAL FRAMEWORK USED IN THIS ASSIGNMENT CONSISTED OF SEVEN MAJOR STEPS



By addressing these tasks, the study provides the Ministry of the Environment with key information which will provide an informed understanding of the implications of acidic precipitation for tourism and recreation.

B. THE APPROACH

The first stage in our approach was to establish the links between acidic precipitation and the environment through a review of available information. Once this was complete, the links between acidic precipitation and recreation and tourist activities were developed. For each of the activities for which there was an established link or for which a link might be established in the future, an estimate of the level of activity and the economic value of the activity was developed for the province and regions within Ontario. Estimates of the quantifiable environmental damage which is currently resulting from acidic precipitation were then related to changes in recreation and tourism activity. The economic consequences of these changes in activity were then calculated. Scenarios were also developed of possible future effects. Exhibit I summarizes the seven key steps in the approach.

In calculating the economic effects, one type of measurement has been used in the main report - changes in expenditures. The expenditure approach has a tendency, in some circumstances, to underestimate consumer benefits and therefore economic effects. This is particularly the case with recreation resources such as fish which are not directly priced. To address this issue an analysis utilizing demand functions developed on the basis of the travel cost method was explored. This analysis considered the total benefits lost by the consumer as identified in accordance with the theory of consumer surplus. In theory, benefits measured by the expenditure method and the travel cost method can be summed to determine total benefit. However, limitations in the expenditure data would have resulted in double counting if this had been done. In addition, data on all the relevant social-economic variables which influence demand were not available. Estimates developed using travel cost data were made, but due to their low reliability, they are not included here.[2]

In addition to these two methods there are a number of other approaches that could have been used for this analysis. These include: the value added approach, surveys and the land value approach. The value added approach was considered but rejected because of data limitations. Surveys to estimate demand were also considered but limited resources would have restricted the number of interviews making it difficult to extrapolate conclusions for the entire province. However, a comprehensive survey of amenity values is currently being undertaken. An approach based on land values was also considered, but a review of the nature of current levels of acidification suggested that it was not feasible to isolate changes in land value from other major factors affecting land values in the current environment.

This report summarizes the major findings of our work and is organized as follows. Chapter Two includes a discussion of the links between acidic precipitation and recreation and tourism. The third chapter describes the current importance of the affected activities and the outlook for these activities in the future. Next, the effects of acidic precipitation on tourism and recreation which can be quantified or described are discussed. The fifth chapter documents the economic implications of these effects. The report closes with a discussion of the major areas which require further work in order that the widespread implications of this complex problem can be more fully understood. In addition to this report is a technical volume consisting of a series of nine appendices which provide the detailed method, data and other information on which the conclusions are based.

Throughout this assignment, a goal has been to develop reasonable estimates of the consequences of acidification and to develop a framework that will allow further analysis by the Ministry of the Environment as the ongoing program of scientific research yields additional information.[3] The assessment of relationships that exist at many steps in the analysis has been hampered by the lack of complete and comprehensive research and data. These information deficiencies have been noted as appropriate. It should be recognized that knowledge of the physical effects of acidic precipitation is limited to date and therefore findings are tentative concerning comprehensive physical effects. The conclusions on economic impact are also subject to similar limitations.

CHAPTER I

1 Ontario Ministry of the Environment Background Paper on Proposed Socio-Economic Studies of Acid Precipitation Toronto, Ministry of the Environment June 5, 1980, p.1.

2 Appendix VIII discusses this alternative measurement technique.

3 Appendix IX describes the analytical framework in detail.

II. LINKS CAN BE ESTABLISHED BETWEEN ACIDIC PRECIPITATION AND KEY RECREATION AND TOURISM RESOURCES

This section of the report explains what acidic precipitation is, the major physical effects it has on the environment and identifies the potential links between the physical environment and recreation activity.

Most of the acidic precipitation in Ontario results from the emission of sulphur oxides and nitrogen oxides, primarily from fossil fuel combustion combining with moisture in the air, forming acids. Consequently, the resulting precipitation (rain, snow, fog) contains sulphuric and nitric acids. Particulate matter and dry chemical compounds also contribute to this phenomenon.

"Normal" rainfall has a pH of about 5.6; precipitation with a pH less than this level is considered acidic. Large areas of Ontario regularly experience precipitation with a pH in the 4.5 to 4.0 range. Occasional occurrences of precipitation with a pH lower than 4.0 have been recorded.

Much of Ontario is subjected to acidic precipitation from sources throughout North America. However, not all environments are equally sensitive to the effects of the deposition of these acids. Areas most sensitive to acidic precipitation are those with hard crystaline bedrock (quartzite or granite) and very thin surface soils. Areas with limestone bedrock have the ability to neutralize the acid and are thus less sensitive to the impact of acidic precipitation. Unfortunately, the Precambrian Shield area of Ontario has the type of physiography which is currently considered the most sensitive to the effects of acidic precipitation. In these areas, effects of acid rain have been observed and documented in the aquatic environments. Acidification results in widespread damage to the ecosystem. During the early stages of the process, shifts occur in the biology of the area, with different types of fish, vegetation and other animal life being affected at each stage of the acidification process. Gradually, the ability of the aquatic ecosystem to sustain life is reduced and eventually an "acid dead lake" results.

The effects of acidification on terrestrial environment of the Precambrian Shield area are less well understood. At present, there is no strong evidence to suggest that vegetation is being severely affected by acidic precipitation or that there will be any changes in the appearance of the landscape.[1] Reduction in forest growth has been reported in Sweden, but it is difficult to attribute these losses directly to acidic precipitation.[2]

However, it is our view that acidic precipitation is having some effects on the terrestrial environment. Further research will be required to determine whether these effects are either beneficial or harmful.

On the basis of available current research, the major link between acidic precipitation and tourism and recreation is primarily through the aquatic environment. It is in the lakes and streams of the Precambrian Shield of Ontario where the most dramatic effects of acidic precipitation on recreation and tourism will be experienced. As a result, this study has focused on the seventeen counties and districts in Ontario which are part of the Canadian Shield (Exhibit 2). In these areas, fishing, waterfowl hunting, moose hunting, and a wide range of water contact activities such as swimming, boating, waterskiing and scuba diving are key recreation and tourist activities. All of these activities are entirely or partially based on the aquatic environment. As a result, this report focuses on the effects of acidification of the aquatic environment on these activities in the Precambrian Shield area of Ontario.

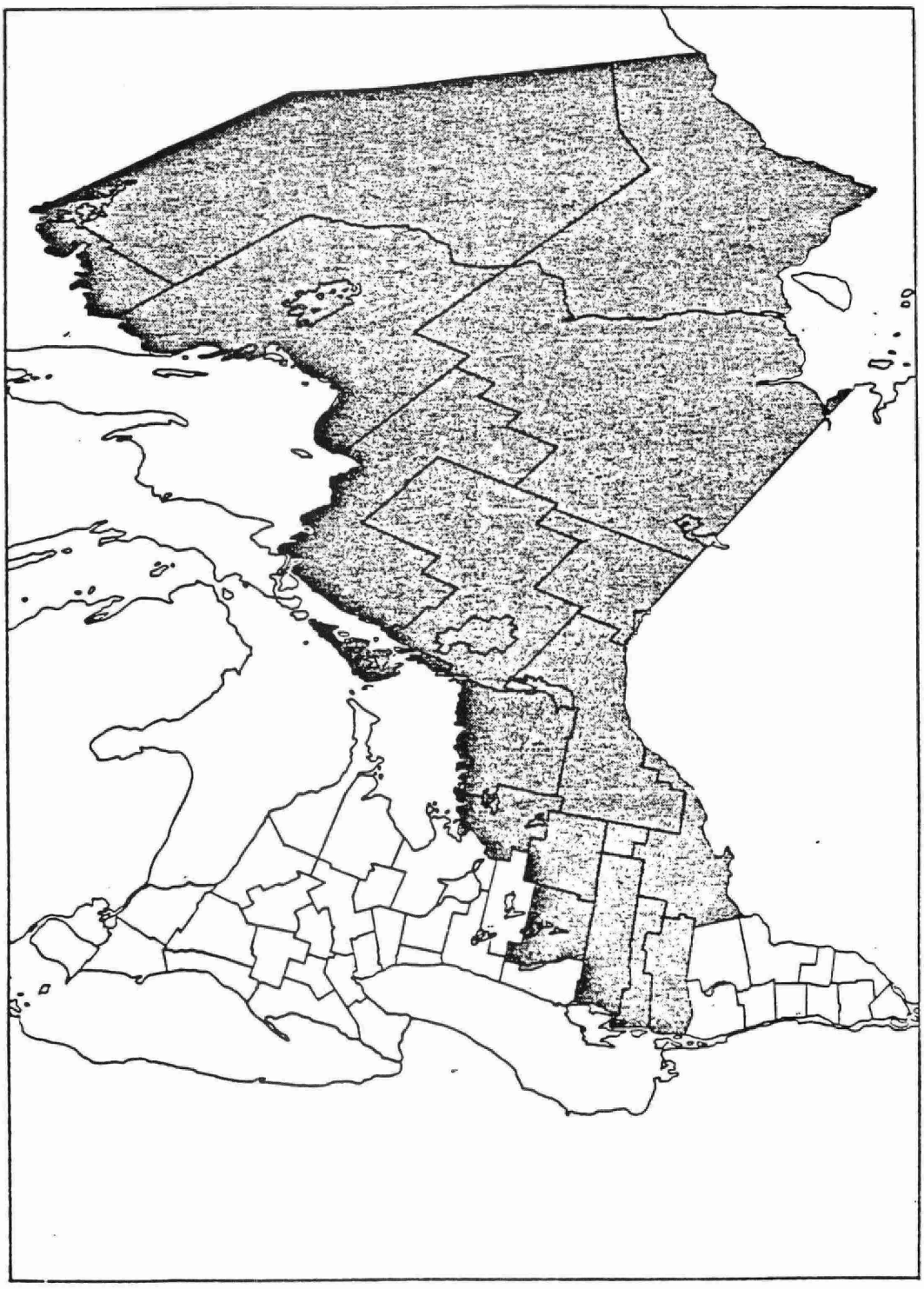
The remainder of this section examines in more detail the potential effects of acidification on each of these key activities: fishing, waterfowl hunting, moose hunting, and water contact activities. In addition, the issue of changes in the perception of the northern environment is discussed.

A. FISHING OPPORTUNITIES WILL DECLINE

Fish are susceptible to acidic precipitation in a number of ways. As a result, the capability of Ontario's lakes to produce fish and, thus,

EXHIBIT 2

STUDY AREA COVERED A LARGE PART OF ONTARIO



recreational fishing opportunities will be reduced if lakes become acidified. Current research indicates that fish are affected in four ways.

1. Failure of Reproductive Capability

This factor is believed to be the most common cause of decline in fish populations as a result of acidic precipitation. Through a series of reactions induced by the acidification of waterbodies, the calcium/sodium ionic balance of fish is affected. This, in turn, produces a subacute physiological stress on the fish which inhibits reproduction.

Not all species of fish are affected at the same pH level, as some species can tolerate higher acid levels than others. As indicated in Exhibit 3, the most sensitive common species in Ontario are smallmouth bass and walleye. Lake trout are also highly sensitive, while yellow perch, lake herring and lake chub are the most tolerant. The effect of this reproductive failure is a gradual reduction in fish populations.[3]

Reproductive failure is the most thoroughly understood effect of acidification on fish. It has been well documented in both field and laboratory situations.

2. Mortality Resulting From Sudden pH Depression

Some waterbodies are subjected to sudden, short duration depressions of pH, known as "acid pulses". These normally can occur during a heavy rain when the watershed does not have time to neutralize the precipitation, and during the spring thaw when the acids that have accumulated in snow during the winter suddenly enter the waterbodies. Some fish, particularly juveniles and recently hatched fry, cannot survive the physiological shock of exposure to these highly acidic waters.

EXHIBIT 3

SMALLMOUTH BASS AND WALLEYE ARE THE MOST SENSITIVE MAJOR SPECIES

PH AT WHICH REPRODUCTION CEASES	MAJOR SPECIES
6.0+ to 5.5	Smallmouth Bass Walleye
5.5 to 5.2	Lake Trout Trout Perch
5.2 to 4.7	Brown Bullhead White Sucker Rock Bass
4.7 to 4.5	Lake Herring Yellow Perch Lake Chub

Source: Appendix I, Exhibit I-4.

The most common result of "acid pulse" is the destruction of an entire year class of a fish species. Predicting the magnitude of the potential damage from "acid pulses" is extremely difficult and highly dependent upon the time of occurrence of the spring run-off, or heavy rains, in relation to the critical stages of a fish's life cycle.

3. Mortality Resulting From Heavy Metal Contamination

Acidic precipitation mobilizes heavy metals such as aluminum, mercury and manganese. As a result, concentrations of these ions can increase in the soils. Runoff and leaching subsequently transfer the metals to the water. If high concentrations of aluminum occur it can cause fish mortality. Fish containing high mercury concentrations can be harmful when consumed by humans.

4. Loss of Nutrients

As a result of acidification, declines in both plant and animal productivity which provide fish with important parts of their diet are likely to occur. Current research suggests that loss of nutrients is not a major cause of fish loss as predator species such as smallmouth bass, walleye, and lake trout become extinct before the prey species.

The relationship between acidic precipitation and reductions in fish populations is the topic on which research has progressed furthest. Of the four major types of effect, reproductive failure and mortality from "acid pulses" are probably the most significant factors. Of these, current scientific knowledge only allows quantifiable links to be made to reproductive failure. As fishing is an important recreation activity and a major tourist attraction, declines in the quality of the fish resource will have effects on tourism and recreation.[4]

B. WATERFOWL HUNTING MAY BE AFFECTED

Waterfowl and, thus, waterfowl hunting may also be affected by acidification of Ontario's lakes. Waterfowl are not affected directly but are vulnerable to indirect effects of acidification, especially the decline in nutrient availability. Losses of invertebrate and fish populations will eventually affect waterfowl, especially during the critical periods in their life cycle. During laying periods and juvenile growth stages, the nutritional requirements of waterfowl require higher proportions of certain invertebrates in the diet. Inability to obtain the required diet will reduce fecundity and the juvenile survival rate. Other waterfowl feed directly off fish and will therefore be affected by a reduction in food supply. Direct mortality as a result of contact with acidified water bodies has not been identified in current research.

Commonly, waterfowl are divided into three major categories. Each category will be vulnerable to declines in nutrient availability. However, the degree of effect will vary due to different breeding and feeding habits.

1. Puddle Ducks

   Based on current knowledge, puddle ducks are the most sensitive to changes in the aquatic food chain as, during the laying season, they feed heavily and lay up to two-thirds of the clutch at one time. Key puddle ducks in Ontario include mallard, pintails, blue and green-winged teals, and the black duck.

2. Diving Ducks

   Diving ducks are not as sensitive as the puddle ducks, as they have a lower nutrient demand during egg formation. Only about three eggs are produced at any one time by these waterfowl. The common goldeneye is the most common type of diving duck in Ontario.

3. Fishing Ducks

Fishing ducks are likely to be the most sensitive of all as their food supply, fish, is affected during early stages of the acidification process. As these waterfowl have territorial feeding habits, this may contribute further to their sensitivity. The merganser is the most common of the fishing ducks in Ontario. Fishing ducks are not normally hunted in Ontario.

Geese which are important for tourism and recreation in some parts of Ontario could also be affected by acidification. As with ducks, the effects would be indirect through the food chain but the effects are likely to be less significant as geese are primarily terrestrial grazers. Many marsh plants which will be affected by acidification also provide a portion of their food supply.

Ontario is an important waterfowl breeding area for all types of waterfowl and many species breed in the Precambrian Shield area. Major species most affected by acidification of Precambrian Shield areas will be mallard, green-winged teals, black duck, common goldeye and the merganser. All of these species breed over a widespread area of the province.

Lack of definitive research is a major problem in attempting to quantify the effects of acidification on waterfowl. The links between acid precipitation and declines in waterfowl population, and thus in hunting opportunities are not clear. In addition, the distribution of habitats and numbers of various types of waterfowl species in Ontario are not known. However, it does appear that the most popular group of ducks for hunting in Ontario, the puddle ducks, will be sensitive to the effects of acidification of their aquatic environment.[5]

C. MOOSE POPULATION MAY ALSO BE AFFECTED

As with waterfowl, the link between acidic precipitation and declines in moose population and, thus, in moose hunting have not been clearly established. However, it appears that there will be some indirect effects.

Moose are found throughout the area of potential acidification of the aquatic environment. During the spring and early summer, moose feed extensively on waterlilies and other water plants characteristic of shallow marshy water. Although moose are fond of water plants, they are not completely dependent on them. Acidification of the aquatic environment would be anticipated to deplete this type of vegetation. This could have some impact on the moose population. But many factors, such as the ability to substitute other types of vegetation, and the ability of moose to migrate to non-acidified areas, are not known.

Widespread losses of aquatic vegetation due to acidic precipitation appears to mean some eventual reduction in the moose population carrying capacity in Ontario which will reduce hunting opportunities. However, at present, it is not possible to predict the magnitude of these reductions.

D. WATER CONTACT ACTIVITIES ARE NOT LIKELY TO BE AFFECTED

Current evidence suggests that water contact activities such as swimming, boating, waterskiing and scuba diving should not be influenced by acidification. Human tissue damage has not been documented as a result of contact with acidified waters. Concern has been expressed regarding delicate membranous tissues such as the human eye, but current indications are that the levels of acidity likely to be experienced in water bodies are not damaging. At present, there are lakes that are used extensively for swimming which have very low

pH's, in the 4.0 - 4.5 range and incidences of eye damage have not been reported at these locations. The pH of the eye is normally about 7.2. While a pH of 6.5 to 8.5 is recommended for swimming water bodies, there is no present evidence that lower pH's are damaging to the eye. For example, some eyewash solutions have a pH as low as 4.5.

Acidified lakes may, in many cases, even become more desirable for water contact activities. The extremely clear appearance of the water could make the lakes aesthetically more attractive for swimming, boating and other activities. However, some concern exists over the potential build-up of a carpet-like moss that can become dislodged from the lake bottom and create a floating green mass, reducing the aesthetic appeal of the water body. Other physical changes such as coloration of the water and the formation of algal masses, etc., can also occur. These phenomena are not well enough understood to predict their widespread occurrence and the response of the human users.

Although not affecting recreation activities directly, in severely acidified lakes where drinking water is drawn directly from the lake, drinking water can become contaminated with heavy metal. This results from acidified water coming in contact with metal water systems and the contact with various ores. Under certain circumstances, these heavy metals could represent a threat to the health of cottagers who draw their drinking water directly from the lake. This damage can be overcome by ensuring that water is left to run before consumption where water systems have not been used for several days. It is worth noting in this regard that most soft drinks are more acidic than acid dead lakes (lakes with a pH below 4.5).

E. PERCEIVED DAMAGES MAY HAVE GREATER EFFECTS THAN ACTUAL DAMAGES

As lakes acidify, the entire aquatic environment will be affected. Gradually, most aquatic life will be eliminated as may some of the mammals and birds that depend upon this environment. Gone will be many of the creatures which help create the environment sought by people seeking a recreational experience. This will have an effect on recreation and tourism which will be in addition to the reduced participation in the activities directly affected.

The motivations for selecting recreation destinations are poorly understood. Much of the benefit from recreation relates to enjoyment of an experience which is a mixture of physical and psychological factors. If the environment is perceived to be damaged and no longer "natural", the quality of the experience could well be damaged to the extent users will no longer desire it. An element of this phenomenon is demonstrated by the fact that resort cottage owners and resort operators are extremely concerned about the effects of their lake being labelled as "acid dead" even though most of the major activities (swimming, boating, etc.) which attract people can still continue. In addition it appears that in some areas of the province all types of water pollution are being blamed upon acidic precipitation.[6]

Based on current research, acidic precipitation will primarily affect fishing, and may result in a reduction in waterfowl and moose hunting opportunities. Evidence also suggests that the water contact activities such as swimming, boating, water skiing, and scuba diving are not likely to be influenced by levels of acidity that could occur in the aquatic environment. However, the effects of the acidification of an aquatic environment may extend beyond the limits suggested by the scientific evidence. The public concern with this poorly understood phenomenon together with the desire for a pure and unspoiled environment may result in a reduced visitation to recreation areas even though current activities could still continue unaffected. Exhibit 4 summarizes the key effects of acidification of the aquatic environment on recreation and tourism.

EXHIBIT 4

FIVE TYPES OF RECREATION AND TOURISM ACTIVITY COULD BE EFFECTED

Activities Effected	Type of Physical Effect	Implications for Recreation and Tourism
Fishing	- direct effects on reproduction and mortality due to acid pulses - indirect effects through food chain	- reduction in quality of fishing
Waterfowl hunting	- indirect through food chain	- reduction in breeding areas
Moose hunting	- indirect through food chain	- may reduce area of suitable habitat
Water contact - swimming - boating - waterskiing - scuba diving	- water likely to become clearer as aquatic environment acidifies - at some stages of acidification aquatic vegetation may create unpleasant water appearance	- water could be more attractive for these activities - "acid dead" label could result in fear factor limiting use - water contact activities could be less desirable in some circumstances

CHAPTER II

1 A review of the literature and discussions with numerous scientists in this area failed to uncover any indication that significant changes in the appearance of the landscape are likely.

2 Jonsson, Bengt, "Soil Acidification by Atmospheric Pollution and Forest Growth". Water, Air and Soil Pollution, V.7, 1977, p. 497-501.

3 Appendix I, p. 3.

4 Quality of fishing is often measured as the number of kilograms of fish caught per hour of fishing.

5 Appendix I, p. 5.

6 Appendix VI. This view was expressed by several people interviewed during the case studies.

III. AQUATIC RECREATION AND TOURISM ACTIVITIES ARE IMPORTANT TO THE ONTARIO ECONOMY

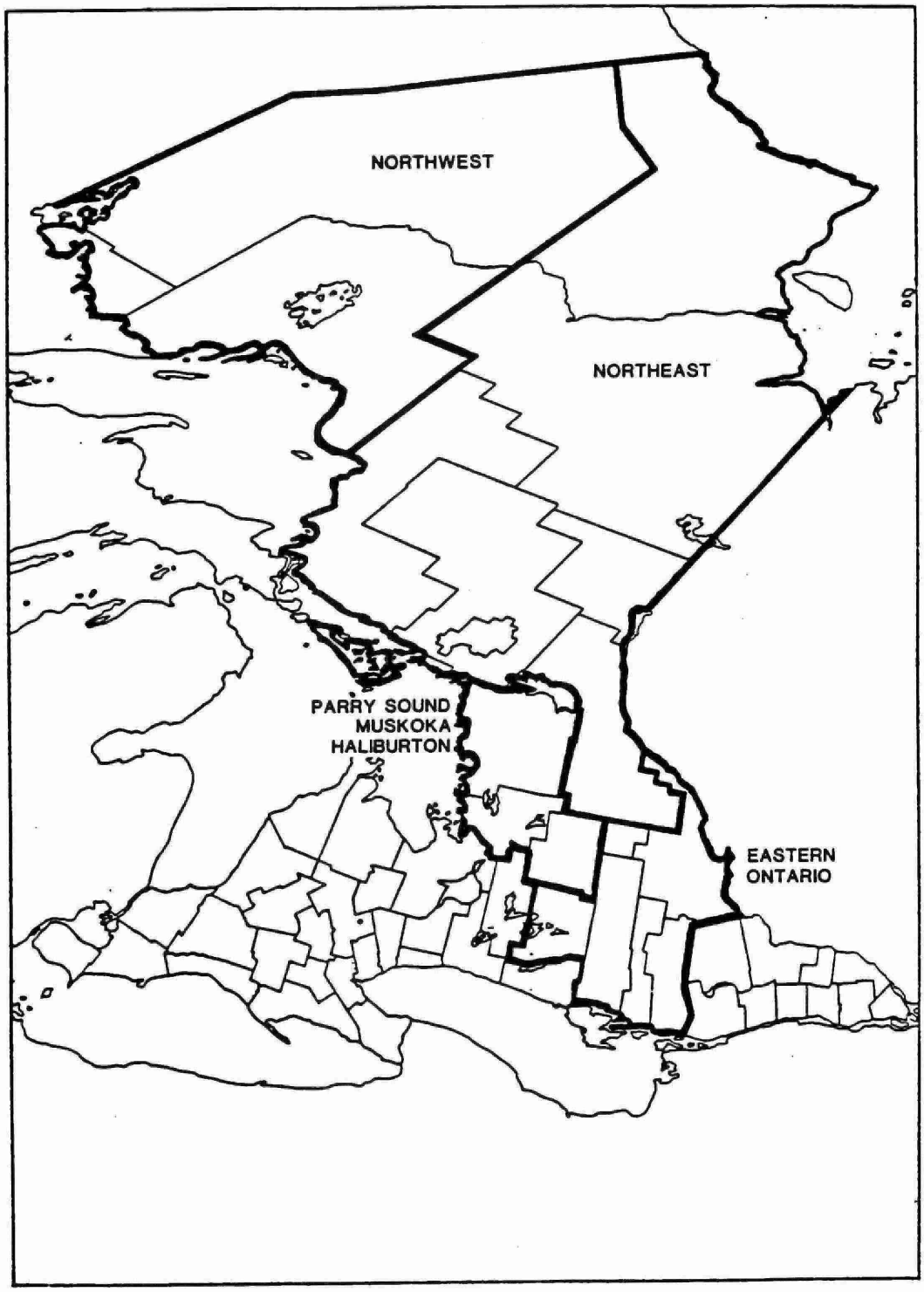
The link between acidic precipitation and recreation and tourism that has been identified is through the aquatic environment. The aquatic environment provides the location for some of the most popular recreational activities in the province. Major aquatic activities include: swimming, boating, fishing, water skiing, scuba diving and waterfowl and moose hunting. Although current evidence suggests that only fishing and waterfowl and moose hunting will be affected, this section discusses all of these activities. This has been done in order to develop an evaluation framework which could be used in the future as further scientific research may discover effects on these other activities.

Available information allowed the division of the areas of potential susceptibility into four regions. (See Exhibit 5). In each of these areas, a profile of recreation and tourism activity was developed. This profile consisted of estimating the level of activity by home-based activities (or day trip occasions)[1] and those involving an overnight stay. These two categories have been further divided into resident of Ontario and non-resident activity. The estimates of home-based activities and overnight stays have been used to calculate the economic importance of the activity by use of the expenditure approach. Average expenditure figures were developed, based upon the activity for day-use and by type of accommodation used for overnight stays. One activity, moose hunting, due to data limitations, could not be treated in this detail and a total figure for the province was developed. In this section, the key conclusions of the importance of aquatic-based recreation and tourism are discussed, together with the outlook for the future of aquatic-based recreation and tourism.

The areas of Ontario susceptible to aquatic environment acidification are important locations for aquatic-based activities. Approximately 42% of the 69 million aquatic-related, home-based occasions and 57% of the 47 million overnight stays generated by these activities occur in the seventeen counties and districts potentially susceptible.[2] Direct expenditures

EXHIBIT 5

POTENTIALLY SENSITIVE ONTARIO DIVIDED INTO FOUR REGIONS FOR ANALYSIS



generated by participants in these aquatic activities throughout Ontario amount to over $900 million annually.[3] In terms of overnight activities, the cottage sector accounts for almost 60% of the total nights in the potentially affected areas.[4] In the future, rapid growth in participation (or demand) in most of these activities is not anticipated. Damage caused by acidic precipitation is only one of the many factors contributing to this outlook.

A. AQUATIC BASED RECREATION AND TOURISM ARE EXTREMELY POPULAR IN ONTARIO

In 1980, the aquatic-related activities of swimming, boating and fishing were among the most popular recreation activities of Ontario residents. In total, aquatic related activities account for an estimated 5% of all home-based recreational activities participated in by Ontario residents.[5] They are also an important reason for trips away from home, attracting many residents and non-residents to the potentially acid-susceptible areas of the province.

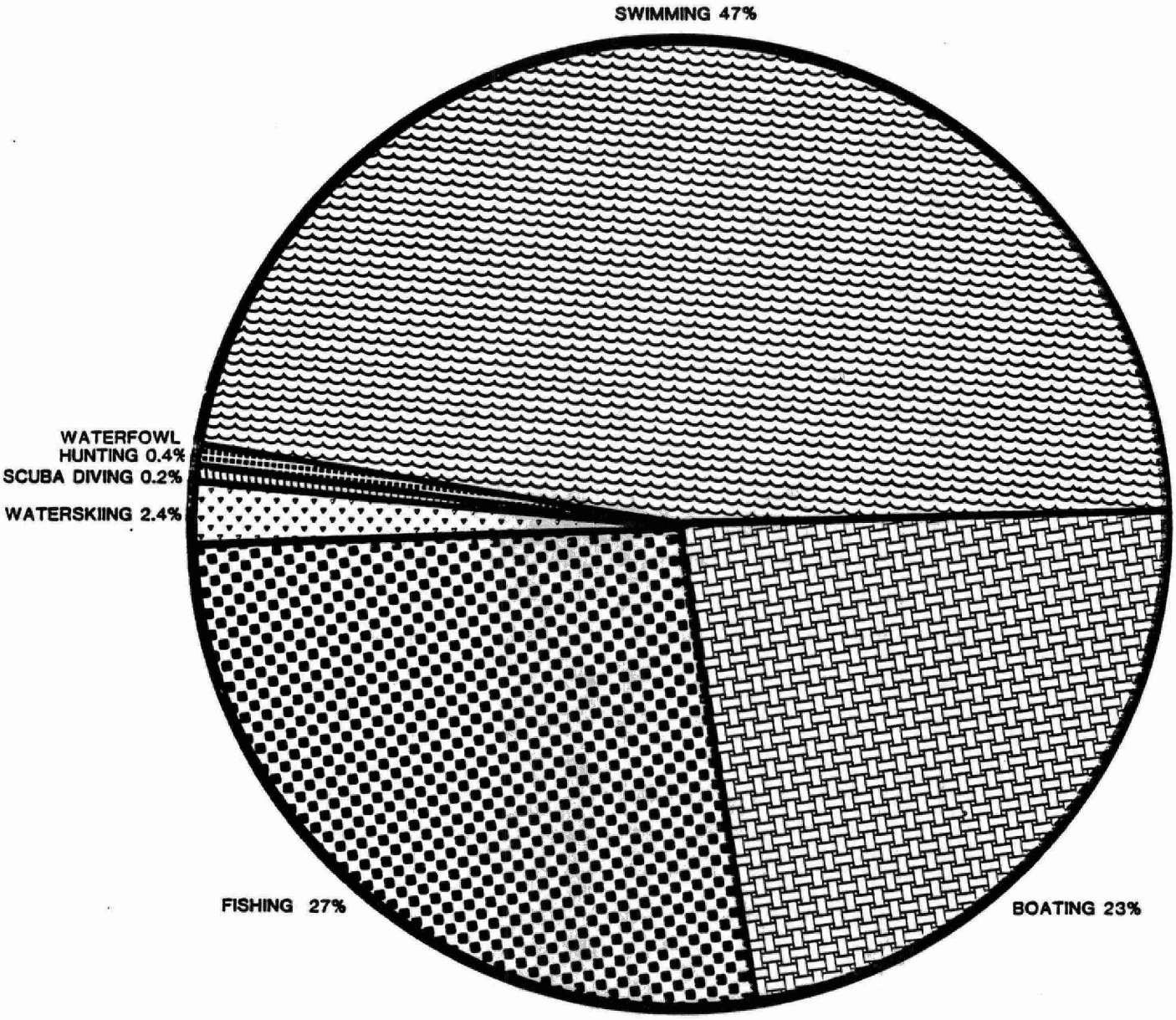
1. An Estimated 69 Million People Participated in Home-Based Aquatic Recreation Activities in Ontario During 1980

Of these activities, swimming in a natural environment, boating and fishing are the most important. (Exhibit 6)

Residents of Ontario account for 98% of the home-based aquatic activity.[6] The potentially acid-sensitive counties and districts account for 29 million or 42% of the people participating in home-based aquatic activities.[7] Almost 50% of all home-based fishing occasions occur in acid sensitive Ontario.[8]

EXHIBIT 6

OUTDOOR AQUATIC RECREATION ACTIVITY
ALL ONTARIO
% OF TOTAL DAY USE ACTIVITY



TOTAL
69,156,000
USER-OCCASIONS

SOURCE : APPENDIX II EXHIBIT II-5

Currie, Coopers & Lybrand Ltd.

	Number of Occasions Occurring in Potentially Sensitive Ontario (000's of Occasions)	Potentially Sensitive Areas as % of Total Occasions in Ontario
Swimming (natural environment)	11,896	37
Boating	6,947	44
Fishing	9,126	49
Water Skiing	890	51
Scuba Diving	54	35
Waterfowl Hunting	109	30
Total	29,022	42

Swimming is the most popular home-based activity in each area, except in Northwestern Ontario where fishing is the most popular.[9]

2. Aquatic Oriented Activities Account for Twenty-Seven Million Overnight Stays in the Potentially Sensitive Parts of Ontario

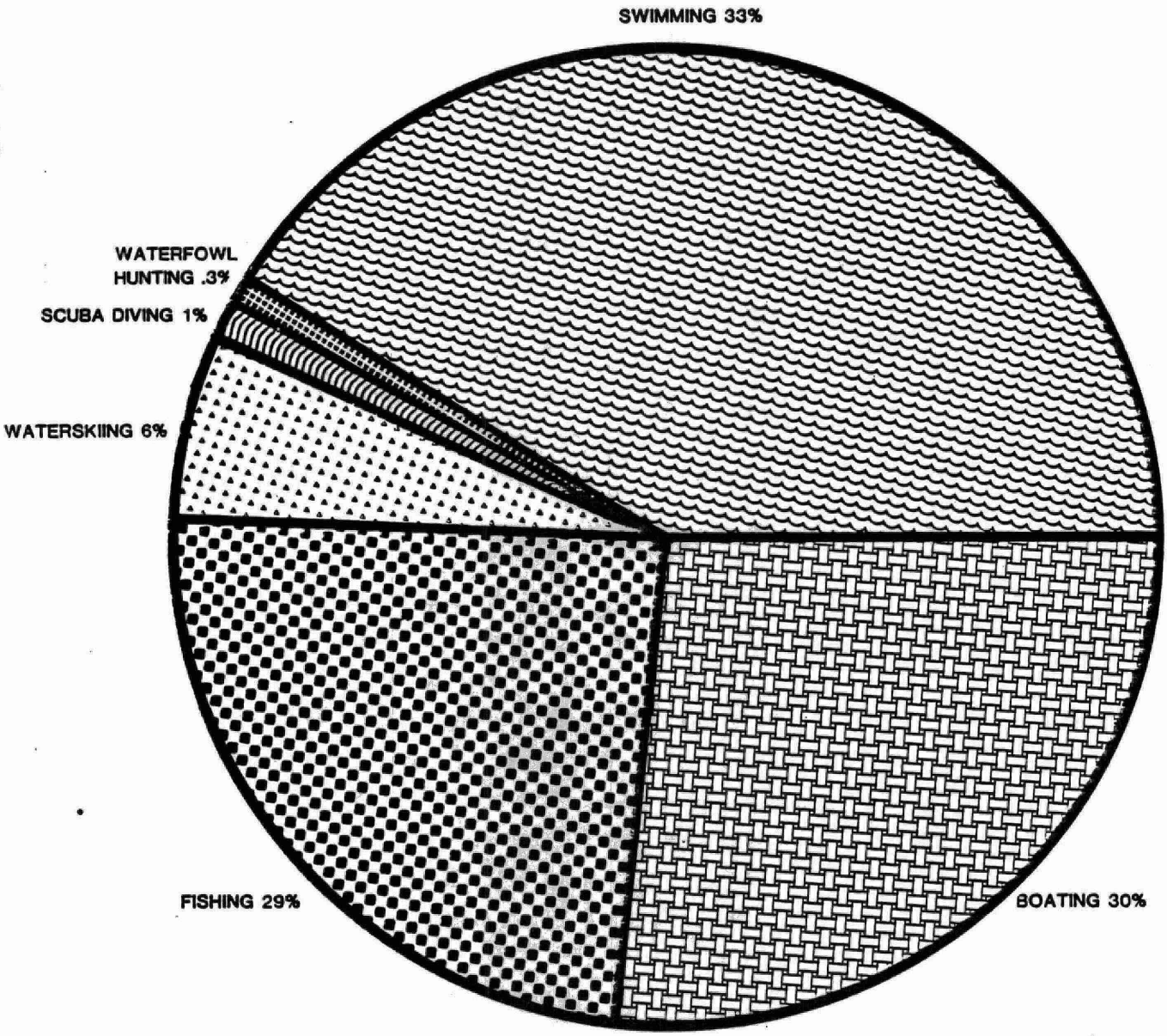
Of all overnight stays generated by these activities in the entire province during 1980, 57% occurred in the susceptible areas of the province.[10] Swimming accounted for the majority of nights in the acid-susceptible areas of the province, followed by boating 30% and fishing 29%. (Exhibit 7)

As with home-based occasions, Ontario residents account for the bulk of the overnight stays, 79% in the sensitive parts of the province.[11] Of the non-residents, Americans account for 46%, other Canadians, 34%, and other foreign visitors, 20%.[12] With non-residents, fishing is the most important activity, accounting for 58% of the non-resident overnight stays in the potentially acidified parts of the province.[13]

EXHIBIT 7

OVERNIGHT STAYS IN POTENTIALLY SENSITIVE ONTARIO

% OF TOTAL OVERNIGHT STAYS



SOURCE: APPENDIX II EXHIBITS II-5, II-6, II-7, II-7, II-8, II-9
TOTAL OVERNIGHT STAYS 7,206,000

Currie,Coopers
& Lybrand Ltd.

	1980 Non-Resident Overnight Stays in Potentially Sensitive Ontario (000's)	% of Non-Resident Overnight Stays for Aquatic Activities
Swimming (natural environment)	769	13.2
Boating	1,487	25.6
Fishing	3,366	57.9
Water Skiing	166	2.9
Scuba Diving	18	.3
Waterfowl Hunting	10	.2
TOTAL AQUATIC	5,813	100.1

This high proportion oriented to fishing supports the view of some observers that fishing in parts of Ontario is a relatively unique experience and thus, capable of attracting visitors from long distances.[14]

The aquatic activities are a very important component of total tourism in the province. In terms of overnight stays by Ontario residents, these activities accounted for 42%[15] of nights away from home in Ontario for recreation and tourism, and for 28%[16] of the total nights away from home for all purposes excluding business. As indicated in Exhibit 8, these activities account for the majority of overnight stays by Ontario residents in the potentially affected areas. Aquatic-based activities account for 8.4 million or 15% of the total non-resident overnight stays (for all purposes) in Ontario.[17]

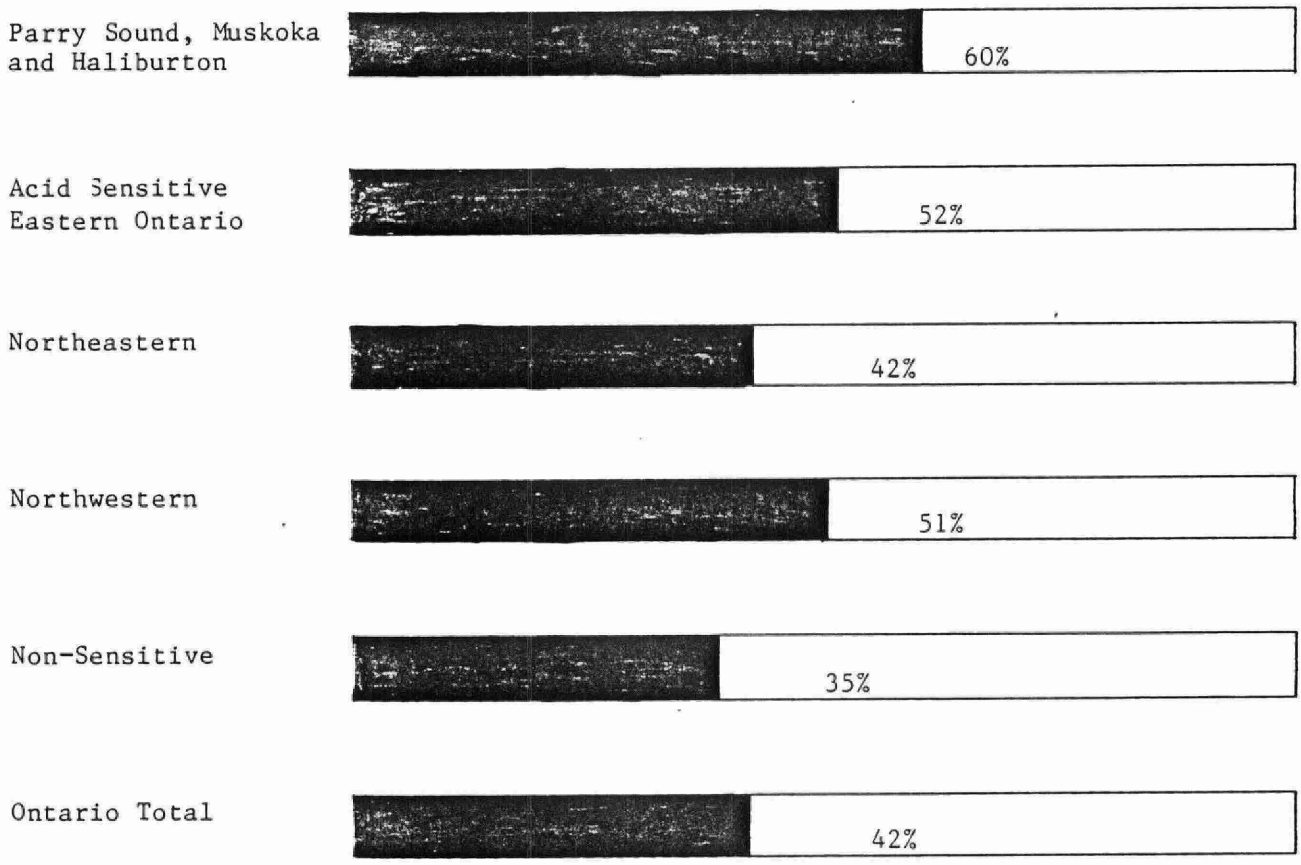
EXHIBIT 8

AQUATIC BASED ACTIVITIES ARE AN IMPORTANT REASON

FOR OVERNIGHT STAYS BY ONTARIO RESIDENTS

Aquatic-Based as a Total of Resident

Overnight Stays (% of Total)



Source: Calculated from Appendix III-7, III-10, III-13, III-16, III-19

B. EXPENDITURES GENERATED BY AQUATIC ACTIVITIES ARE IMPORTANT TO ONTARIO

Aquatic-based activities directly generate over $917 million of direct expenditures annually in Ontario.[18] Indirect expenditures generate another $734 million annually.[19] In keeping with most other studies of recreation and tourism, the costs of major purchases such as boats and cottages have been excluded. Employment generated by these direct expenditures amounts to approximately 40,000 man years per annum.[20] These aquatic activities are estimated to contribute 12-18% of total tourist expenditures in the province.[21]

1. Direct Expenditures Related to Aquatic Activities in Acid-sensitive Regions Amount to About $450 Million

Home-based activities account for $228 million, or approximately 50% of these expenditures.[22] The areas susceptible to acidification account for about 50% of the total provincial expenditures on these activities.[23] Regionally these expenditures for 1980 were as follows:[24]

	Direct Expenditures ($ Millions)	% of Total
Sensitive Ontario		
Parry Sound, Muskoka and Haliburton	$120	13%
Acid Sensitive Eastern Ontario	135	15%
Northeastern Ontario	125	14%
Northwestern Ontario	71	8%
Total Sensitive Ontario	451	50%
Non-Sensitive Ontario	466	50%
Total Ontario	917	100%

In addition to these direct expenditures, an additional $750 million of indirect expenditures is generated within the Ontario economy.[25] The direct and indirect expenditures relate primarily to transportation, accommodation and food.[26]

2. Aquatic-Based Activities Are an Important Component of Provincial Tourism and Recreation

In addition to the dollars spent and employment created, it is necessary to understand the importance of aquatic activities in the sensitive areas within the total recreation and tourism picture in Ontario. It is estimated that aquatic-related activities account for about 10% - 15% of the estimated $7.5 billion generated by tourism in Ontario.[27] The seventeen counties and districts susceptible to acidification account for about 50% of these direct expenditures generated by aquatic recreation activities.[28]

3. Employment Generated by Aquatic Activities in Sensitive Areas is Estimated at 20,000 Man Years

Employment opportunities generated by the direct expenditures are estimated at 40,000 man years in the province as a whole, and 20,000 in the acid sensitive portion.[29] In some of the acid-sensitive areas of the province, these aquatic related recreation and tourism jobs make a sizeable contribution to total employment opportunities.

	Number of Employment Opportunies	% of Total Area Labour Force[30]
Parry Sound, Muskoka and Haliburton	5,500	16%
Acid Sensitive Eastern Ontario	5,900	3%
Northeastern Ontario	5,700	2%
Northwestern Ontario	3,200	3%

C. OVERNIGHT PARTICIPATION IN AQUATIC ACTIVITY IS HIGHLY RELATED TO COTTAGE USE

Ontario has an estimated 330,000 cottages, of which 65% are located in areas that have the potential for acidification, Exhibit 7. Of these cottages 84% are owned by Ontario residents, U.S. residents own 14%, and residents of other Canadian provinces own 2%.[31] This is important as most owners of cottages purchase them to have access to aquatic-based recreation activity.

Cottages are the most important access point for aquatic-based overnight recreation activities, both throughout the entire province and within the areas of potential acidification.[32] Camping is the next most important, followed by the commercial accommodation sector which includes: lodges, resorts, hotels and motels.[33] This pattern is similar in all parts of the province.[34]

Non-residents of the province have a somewhat different pattern, with a much larger share of aquatic-based activities based in the commercial sector, followed by the cottages.[35] As a result, non-residents have more flexibility in changing their use pattern in response to acidification of the aquatic environment and are therefore more likely to respond in the short term.

D. ACIDIC PRECIPITATION IS ONLY ONE OF MANY FACTORS INFLUENCING THE FUTURE OF AQUATIC-BASED RECREATION AND TOURISM

At present, acidic precipitation is often perceived to be the cause of all sorts of problems facing Ontario's recreation and tourism industry in the Precambrian Shield area. However, there are a number of other factors which are currently affecting the industry, many of which are currently creating problems for the industry, and will continue to do so in the future.

EXHIBIT 9

65% OF ONTARIO COTTAGES ARE LOCATED IN ACID-SENSITIVE ONTARIO - 1980*

	Number of Cottages	% of Total
Parry Sound, Muskoka, Haliburton	83,700	25
Acid Sensitive Eastern Ontario	59,900	18
Northeast	53,700	16
Northwest	19,700	6
Total Acid Sensitive	217,000	65
Remainder of Ontario	113,000	34
Total	330,000	99

* Source: Appendix III, Exhibit 24.

In order to understand the future impact of acidic precipitation on aquatic activities, an indication of the current outlook for these activities adds a useful perspective. A number of factors on both the supply and demand side suggests that rapid growth in participation in these activities is unlikely, and total participation could decline or experience only modest growth by 2001.[36]

1. Most Demand Indicators Suggest Modest Growth in Future Participation in These Activities

Studies of future demand for recreation and tourism in general suggest five key variables as the main motivation for growth. These include:

- population growth and age structure,
- leisure time availability,
- trends in activity participation,
- income availability, and
- foreign cost differential.

Current examination of these factors suggests little reason to anticipate strong growth in aquatic-based recreation and tourism.

a. Population Growth and Age Structure Are Not Expected to Contribute to Rapid Increases in Level of Recreation and Tourism Activity

During the late 1960's and early 1970's, rapid growth occurred in the both the number of home-based occasions and overnight stays associated with aquatic-based activities. One of the major reasons for this was changing demographic patterns, particularly the aging of the baby boom population into the most active age categories for recreation and tourism activity. However, in the future, demographic changes indicate that there will not be such rapid increases in participation.

Virtually all forecasts of population growth suggest modest growth in the future, an average of less than 1% annually to 2001 in the Province of Ontario.[37] A similar situation exists in neighbouring provinces and states.

More significant than the declining rate of growth will be the changing age structure of the population. During the next twenty years, the number of people under nineteen in Ontario will decline.[38]

ONTARIO POPULATION (000's)

	1976	2001	Change
0 - 11	1,594	1,372	- 222
12 - 19	1,287	950	- 337
20 - 34	2,047	2,134	87
35 - 49	1,436	2,600	1,164
50 - 64	1,161	1,791	630
65+	739	1,737	998
	8,264	10,584	

The importance of this trend to recreation and tourism is that participation in aquatic-based recreation activities declines with age.[39]

Participation Rate by Age Group

AGE GROUP	SWIMMING	FISHING	WATERSKIING
12 - 19	92%	50%	21%
20 - 34	80%	42%	15%
35 - 49	65%	38%	6%
50 - 64	44%	28%	2%
65+	17%	17%	1%

The combination of: the slow rate of population growth; aging of the population; and declining rate of participation with age, results in slow rates of growth in participation in aquatic activities. Beyond 2001, the rapidly aging structure of the population will have a more dramatic impact with declines occurring in the level of participation in some activities.[40]

b. There Is Little Evidence to Suggest Rapid Growth in Leisure Time

Lack of time is a dominant constraint to participation in most recreation activities: aquatic-based activities which require travel are especially affected. The length of the work week has not been shortened since the late 1940's.[41] Flex time and a trend toward slightly longer paid vacations may provide some additional leisure time. However, the fact that more households have two participants in the labour force suggests that more time away from employment must now be devoted to domestic activities. Information from the Ontario Recreation Survey suggests that time spent in recreational activities reaches a peak in the life cycle regardless of the amount of free time.[42] Thus large increases in participation as a result of changing patterns of work are unlikely.

c. Few People Express A Strong Desire For More Participation in Aquatic Activities

Analysis of the Ontario Recreation Survey indicates that there is little unfilled demand for participation in the key aquatic activities by non-participants.[43] This suggests that sharp increases on the level of participation are not likely due to changes in preferences for these activities.

d. Anticipated Income Growth Cannot be Used to Support Expectation of Increased Activity in Aquatic-based Recreation

The Ontario Recreation Study has also demonstrated that participation in aquatic-based activities generally rises with income.[44] In recent years, 1975 - 80, there has been a slowing of real income growth. Similar slow growth in real income is forecast by many economists until the mid-1980's.

This slow growth in real income, together with rapidly rising energy costs, and therefore travel costs may be a further negative factor as the income available for recreation and tourism may cause a reduction in the number of trips taken.

Research suggests that consumers will shift to smaller, more energy efficient automobiles as energy prices rise as opposed to drastically reducing the amount of travel.[45] Thus, while growth in recreation activity may not occur due to income and energy factors, large declines in participation also appear unlikely.

e. Foreign Recreation and Tourism Cost Differential Could Also Have Negative Implications

Currently, the Canadian dollar is selling at its lowest level since the 1930's. The most significant effect this has had is a reduction in the number of Ontario residents taking vacations outside of Canada. In spite of the low Canadian dollar, there has been no growth in the number of United States visitors staying overnight in Canada. The number of other foreign visitors has however shown more significant growth, but it still accounts for a very small portion of total visitors, and a very small portion of these

visitors, estimated at 13%, participate in aquatic related activities.[46] If construction of major energy projects causes the Canadian dollar to appreciate against other currencies even these small gains may be lost.

Demand factors suggest that at best only modest growth can be anticipated in recreation and tourism in the next few years and that no growth or a slight decline are as likely as growth.

2. Three Key Supply Factors Could Also Constrain Further Growth In Aquatic Activities

On the supply side three factors are likely to influence future growth in aquatic-based recreation and tourist activities. Fishing and hunting are highly dependent upon the supply of opportunities to participate, the quality of the fish and game resource, and the ability of these resources to be self-sustaining. In most parts of Ontario, declines in the quality of the fishing and moose hunting resource are developing as overharvesting of the resource is common.[47] The availability of well located land for new cottage development is also expected to restrain rapid growth in aquatic-based activities. Currently over 60% of all overnight stays associated with aquatic-based activities originate from the cottage sector. Another supply factor which will likely influence aquatic-based activities is the reduction in the number of resorts and other types of commercial accommodation. The following section discusses each of these supply factors.

a. Over-harvesting of Fish and Moose Is Common in Ontario

At present levels of harvest, all accessible parts of Ontario's inland fisheries are experiencing overfishing.[48] In addition, the Great Lakes have been depleted of many of the desired sport fishing species.[49] Some exceptions to this condition exist in non-road accessible parts of Northern Ontario. This widespread problem is particularly

serious for operators of fishing lodges in Northern Ontario. Without better management, reductions in the quality of the fishing experience will result.[50]

A similar situation exists with moose. Currently, the Ministry of Natural Resources is embarking upon a program to double the moose population by 2001.[51] However, in order to accomplish this, a more restrictive licencing and open season program is being developed.

As a waterfowl census does not exist for Ontario, it is not possible to reach definite conclusions about supply trends of the waterfowl population in the province. However, some observers feel that there are not serious supply and demand problems with waterfowl.

b. Rapid Increases in the Number of Cottages Appear Unlikely

Currently, there is very little vacant land in Ontario with waterfront, convenient to major urban centres. As a result, large increases in the future supply of cottages are unlikely. Current construction already appears to have moderated from the rapid growth period of the 1950's and 1960's.[52] At present, there is little evidence that major attempts to market cottages without waterfront will be successful.

c. The Number of Resorts and Seasonal Hotels Continues to Decline

Throughout most of the areas of Ontario where recreation and tourism are dependent upon aquatic activities, the number of establishments catering to tourists continues to decline. Many establishments are unable to provide activities for a longer season so that modern facilites of a higher quality can be provided. In the road-accessible northeastern and northwestern parts of the province, the accommodation sector

is also faced with the decline in quality of the fishing, primarily as a result of overharvesting. It will be difficult for many of these operators because of their remote locations to develop new markets such as the family vacationer.

On the supply side, the three factors: decline in the quality of the resource base; the lack of well located vacant cottage land; and the reduction in the number of resorts and lodges; suggest that significant growth in aquatic-based recreation and tourism is unlikely.

Aquatic-based activities are a key component of recreation and tourism in Ontario. Activities such as fishing, swimming and boating are very popular among residents and attract many non-residents to the province. As a result of this popularity, many dollars are spent participating in these activities. In the future, rapid growth in both home-based and overnight participation in aquatic activities is not expected. Many factors contribute towards this outlook, particularly over-fishing on the supply side and demographic factors on the demand side.

CHAPTER III

1 Occasions is a basic unit of participation and is defined as one person participating in one activity for a period of time during one day.

2 Calculated from Appendix II, Exhibits II-5, II-6, II-7, II-8 and II-9.

3 Appendix III, Exhibit III-8.

4 Appendix III, calculated from Exhibit III-7, total nights at private cottages for aquatic activities 26,868 divided by total nights at all accommodation for aquatic activities 47,433, 56.6%.

5 Based upon the estimated number of resident day use aquatic activities of 68 million as contained in Appendix II divided by an estimated 1,264 million of all types of home-based recreational activities.

6 Calculated from Appendix II, Exhibit II-5.

7 Calculated from Appendix II, Exhibit II-5, II-6, II-7, II-8 and II-9.

8 Calculated from Appendix II, Exhibits II-5, II-6, II-7, II-8 and II-9.

9 Detailed breakdowns of home-based occasions by activity and region are contained in Appendix II, Exhibits II-6, II-7, II-8 and II-9.

10 Calculated from Appendix II, Exhibits II-5, II-6, II-7, II-8 and II-9.

11 Ibid.

12 Ibid.

13 Ibid.

14 See for example Ontario Ministry of Northern Affairs The Fishing and Hunting Lodge Industry in Northern Ontario, Toronto, December 1979.

15 Calculated from Appendix III-7, III-10, III-13, III-16, III-19.

16 Ibid.

17 Estimated from Appendix II.

18 Appendix III, Exhibit III-8. Direct expenditures are defined as those made for the purchase of goods and services by people participating in recreation and tourism from industries servicing them. These include the following sectors: accommodating, food/beverage, service stations, amusement/recreation, retail sales, and public transportation.

19 Based upon estimated direct expenditures of $917 million and a multiplier for the province of 1.8 for tourist and recreation expenditures which result in indirect expenditures of $734 million. The 1.8 multiplier is estimated from the study The Economic Impact of Tourism in Ontario and Regions. The indirect expenditures are the effects which result from the direct expenditures on other sectors of the economy: e.g., wholesale trades, manufacturers, food producers.

20 Based upon total direct expenditure of $917 million divided by $23,000 average amount of direct expenditure per man year of employment in Ontario. As estimated from Larry Smith & Associates Ltd. Economic and Social Importance of Ontario Tourism, Toronto, March 1978.

21 Ibid. 1976 total direct expenditures of $4.7 billion updated to June, 1980.

22 Calculated from Appendix III, Exhibits III-8, III-11, III-14, III-17, III-20.

23 Ibid.

24 Ibid.

25 See reference 18.

26 Appendix III, p. 7.

27 See reference 20.

28 See reference 22.

29 Calculated from Appendix III, p. 8.

30 Development from 1976 Census updated to 1980 using average Ontario growth in employment as estimated from Statistics Canada Employment Earnings and Hours Catalogue 72-002.

31 Appendix III, Exhibit 24.

32 Appendix III, Exhibits III-7, III-10, III-13, III-16 and III-19.

33 Appendix III, Exhibit III-7.

34 Appendix III, Exhibits III-10, III-13, III-16, III-19.

35 Appendix III, Exhibit III-7.

36 Appendix IV discusses this outlook in more detail.

37 Appendix IV, p. 1.

38 Appendix IV, p. 2.

39 Appendix IV, Exhibit IV-1.

40 This assumes current demographic trends and current levels of participation by age.

41 International Labour Office, Year Book of Labour Statistics, Geneva, various years.

42 Ontario Tourism and Outdoor Recreation Planning Study, Ontario Recreation Survey, Volume 4 Free Time, Toronto, December 1978.

43 Appendix IV, p. 3.

44 Ibid.

45 Currie, Coopers & Lybrand Ltd. Study of Taxation and Spending Policies with Respect to Energy Use prepared for the Province of Nova Scotia, Department of Mines and Energy, January 1981, pp. 22-64.

46 Appendix II, 1,767,000 other foreign nights for aquatic activities, Exhibit II-3, divided by total number of other foreign tourist nights 13,253,000, Appendix II, p. 5.

47 Ontario Ministry of Natural Resources Crown Land Recreation Study - Phase 2, March, 1979.

48 Ibid.

49 Strategic Planning for Ontario Fisheries Work Group Ontario Fish Yield Estimates, March 1979.

50 Quality of fishing has been used in this report to refer to the number of kilograms of fish caught per hour of fishing.

51 Ontario Ministry of Natural Resources Moose Management Policy Announced, Toronto, M.N.R. Newsrelease, November 26, 1980.

52 Ontario Ministry of Natural Resources Cottages and Cottagers, Toronto, June 1979, P. 11 and W.M. Baker The Nature and Extent of Vacation Home Data Sources and Research in Canada prepared for Statistics Canada, 1974.

IV. MEASURABLE EFFECTS ARE CURRENTLY LIMITED TO FISHING

At the present time, only small portions of Ontario have acidified water bodies. Based upon these levels of acidity, only small amounts of physical damage limited to a reduction in fish productivity can currently be quantified. The estimate of fish loss is most likely conservative as the implications of "acid pulses" are not included. Based upon current information, it appears that other physical damages to waterfowl, moose and the physical appearance of the water are not currently widespread.

In the future, the level of physical damage could increase significantly as large portions of Ontario could acidify if increases occur in the amounts of acidic precipitation. At this time it is not understood what the effects of a continuation in current levels of acidification will do to Ontario's fisheries.

In this section the current levels of acidification are described together with the impact that this has had on aquatic-based recreation activity. The potential impact of possible future acidification is then examined together with a discussion of the additional research required to provide more confidence to these estimates.

A. CURRENTLY LESS THAN 1% OF ONTARIO'S WATER BODIES ARE ACIDIFIED

The Ministry of the Environment of Ontario has classified Ontario lakes by susceptibility to acidification.[1] The five categories are as follows: I) acidified lakes, II) extremely sensitive lakes, III) moderately sensitive lakes, IV) lakes of low sensitivity, and V) not sensitive lakes. The classifications are based on the buffering capacity of the lake which is highly dependent upon the alkalinity of the waterbody measured by the total inflection point alkalinity (TIA) method.[2] Alkalinity is thus a measure of the acid neutralizing capacity of an aquatic ecosystem. As indicated in Exhibit 10, only small portions of the province are currently classified in the acidified categories and these are almost entirely limited to the District of Sudbury and the Killarney area of the District of Manitoulin.

Based upon this classification system, it is possible to make a calculation of estimated losses in fish productivity.[3] To do this, the first step is to classify fish productivity into geographic regions and the five lake susceptibility categories. Productivity is calculated, based on available fish productivity estimates for major areas of the province.

In order to calculate the loss in productivity, it is necessary to make estimates of the effects on fish reproductive capability for each lake susceptibility category.

This requires that the relationship between pH and loss in fish reproductive capability be established. However, an inventory of Ontario lakes by pH does not exist, but an inventory by TIA value is available. The relationships between pH and TIA are not certain at low pH's. As a result, the following estimates have been made regarding fish productivity for all species for each category of susceptibility.[4]

Category I	- acidified	- no reproduction
Category II	- extremely sensitive	- 20% loss
Categories III - V		- no losses in productivity

On this basis current losses in productivity are estimated to amount to 167,626 kg. annually or less than 1% of total productivity in the susceptible area of Ontario.[5]

	Total Potential Productivity Kg.	Current Loss in Productivity Kg.	% Decline
Parry Sound, Muskoka, Haliburton	366,148	13,242	-3.6%
Acid Sensitive - Eastern	636,695	63	-
Northeast	3,339,918	153,183	-4.6%
Northwest	13,810,121	1,138	-
Total Susceptible Ontario	18,152,882	167,626	-0.9%

The Northeast accounts for 91% of the current productivity loss in areas susceptible to acid precipitation.

Activities other than fishing are not likely to be affected at this level of acidification. Moose and waterfowl should be able to find alternative sources of food supply. In addition, there is no evidence that water contact activities are being affected by current patterns of acidification.

B. IN FUTURE, LARGE PORTIONS OF THE PROVINCE COULD BECOME ACIDIFIED

The current effects of acidification on recreation and tourism do not appear to be significant, the problem appears to be one for the future. To understand the extent of the potential effects, two future scenarios were developed, an intermediate situation and a worst case.

The intermediate scenario assumes a continuation of current trends in acid deposition and therefore projects an increase in the number of acidified lakes. This scenario assumes that those lakes which are currently classed as extremely sensitive (Category II) become acidified lakes (Category I) and thus lose all fish productivity. In addition, moderately sensitive lakes (Category III) become (Category II) and thus lose 20% of their productive potential. A time-frame for this scenario to be realised was projected to be twenty years. This estimate was made after discussion with those most knowledgeable in this field but is unsupported by longitudinal studies of acidification. Under this scenario, 735 thousand kilograms of productivity are lost. The most concentrated loss would be in the Parry Sound, Muskoka and Haliburton areas.6

	Loss in (000's Kg.) Productivity	% of Total Productivity in Each Area
Parry Sound, Muskoka, Haliburton	109	30%
Acid Sensitive Eastern	15	2%
Northeastern	377	11%
Northwestern	233	2%

The worst case scenario assumes acidification or partial acidification of susceptibility categories I, II and III. Under this scenario, most water bodies in the Muskoka, Haliburton and Parry Sound area will be acidified and a total of 20% of the fish productivity in susceptible Ontario will be lost. These water bodies will no longer be able to sustain fish and many other forms of aquatic life. The anticipated results are shown in the following table.[7]

	Loss in Productivity (000's Kgs.)	% of Total Productivity In Each Area
Parry Sound, Muskoka, Haliburton	303	83%
Acid Sensitive Eastern	81	13%
Northeastern	958	29%
Northwestern	2,272	16%
Total	3,614	20%

A total of 3.6 million kilograms of annual fish productivity is estimated to be lost at this level of acidification. However, it must be stressed that until further information is available, it cannot be predicted as to when this phenomenon will occur and what types of additional loadings must take place to bring about this extreme level of acidification.

Although they cannot be quantified, it is our view that, at these levels of future acidification, other physical damages will occur which will affect recreation and tourism. Stress is likely to be felt by both waterfowl and moose populations and changes in the physical appearance of a widespread number of waterbodies are likely to have occurred. As a result, in some areas of the province, the entire aquatic environment could be severely altered.

C. FURTHER RESEARCH IS LIKELY TO ALTER THESE ESTIMATES

Several factors which determine the effects of acidic precipitation of fish population are not well understood. As further research becomes available the estimates of productivity loss developed in this report will be confirmed or new estimates will be developed. The key areas requiring further research to raise confidence in these estimates are: an understanding of the effects of acid pulse; chemical profile for additional Ontario lakes; and a good understanding of future acid loadings, their dispersion patterns, and the effects of long-term exposure to acidic precipitation.

In conclusion, we are currently able to quantify the effects of acidification on fish reproductive capability and, thus, on fish production and supply. Though the absolute numbers are small in relation to total fish productivity, current estimates of the deterioration in the fishery are significant in localized areas and when considered in relation to the excess of demand in relation to the supply of this resource. In the future, the potential exists to have extensive amounts of the sport fishing of the province destroyed and a significant area of the province could experience widespread damage to its aquatic environment.

CHAPTER IV

1 Appendix V, p. 1.

2 This method of classification is discussed in Ministry of Environment Acid Sensitivity Survey of Lakes in Ontario, March 1981, Preface p. i.

3 Appendix V, p. 3.

4 Appendix V, pp. 2-3.

5 Appendix V, Exhibits V-7, V-8, V-9, V-10, V-11, V-12.

6 Ibid.

7 Appendix V, Exhibits V-7, V-8, V-9, V-10, V-11, V-12.

V. AQUATIC ACIDIFICATION COULD HAVE WIDESPREAD ECONOMIC IMPLICATIONS IN THE FUTURE

In order to be able to make decisions about the investment in pollution abatement, to moderate levels of acidic precipitation, it is desirable to develop estimates of the dollar value of the various types of resources lost, including recreational resources. At the present time, quantification of the recreational resource losses can only be made for fishing and the reduction in related expenditures. For other types of recreation and tourism activities, only the qualitative implications of the potential economic damage can be identified.

The final step in this analysis of the effects of aquatic acidification on recreation and tourism is to link changes in the resources base to changes in user behaviour. To develop an understanding of the response to a reduction in fish supply, two approaches were used. Catch per unit effort functions were developed which relate the supply or productivity of an area to the demand level or effort of anglers.[1] Based on available information, catch per unit effort functions for fishing were developed for each of the four regions used throughout this study. Based on these functions, it is possible to estimate the level of reduction in angler effort that will result from reductions in fish productivity. Based on this relationship, resulting changes can be calculated in angler occasions and related overnight stays. The economic implications of this reduction in activity are then determined.

The second method of understanding likely changes in users habits in responses to changes in the aquatic environments was through case studies.[2] Initially, it had been felt that case studies of acidified lakes could be used. However, it was extremely difficult to locate representative case studies. The greatest problem is the lack of historic information on the acidification of the water bodies. In addition, the majority of lakes currently acidified are small and often not easily accessible and, as a result, they are not well developed for use by recreation seekers and tourists. A few exceptions do, however, exist, such as the often referred to examples of Clearwater, Chiniguichi, and Kukagami Lake, all in the Sudbury area.

Due to the lack of cases of acidification impacting significant recreational lakes, the case studies focused on determining the effects which the range in the quality of fishing resources have on recreation activities. The case studies were directed at developing an understanding of the importance of other activities in the areas which have greatest potential for aquatic acidification. These areas are the Parry Sound, Muskoka and Haliburton areas and the Northeast, particularly the Sudbury and Killarney areas.

As current damages from acidification are localized, and quantifiable damage estimates are limited to the associated sports fishing sector, economic losses to date are not, therefore, large. Currently, there is a great deal of misunderstanding about the effects of acidic precipitation, and the imagined effects, (i.e., the "fear factor") could result in expenditure losses not directly related to the decline in resource quality. During case studies undertaken for this study, numerous realtors and resort operators mentioned the negative effects on their area of the perceived problems of acidic precipitation.

In the future, the economic losses will increase substantially as other activities are affected and the entire image of much of Ontario's prime recreation and tourist area is altered.

A. CURRENT QUANTIFIABLE ECONOMIC LOSSES RELATE TO FISHING

At current levels of acidity the economic effects on fishing are small in relation to total recreational fishing activity. Other aquatic based activity is not likely to be affected significantly. At present, the perceived effects could have a large impact on recreation activity.

1. Current Reductions in Direct Fishing Expenditures as a Result of Losses in Fish Productivity are $2.7 Million Annually

The loss of 168 thousand kilograms of fish productivity is estimated to result in a 0.9% decline in angler hours, a reduction of 922,000 hours in the entire Province. The changes

in effort are limited to Northeastern Ontario and the Parry Sound, Muskoka and Haliburton area.[3]

	Total Effort hours (000's)	Decline In Effort hours (000's)	% Change
Parry Sound, Muskoka and Haliburton	4,654	150	-3.2%
Acid Sensitive Eastern Ontario	6,831	1	-
Northeastern	16,700	766	-4.6%
Northwestern	55,240	5	-

These estimates of decline in effort are based upon regional catch per unit of effort functions for fishing which relate fishing effort in hours to level of productivity in kilograms. This level of decline in effort has produced an estimated reduction in direct expenditures for fishing amounting to approximately $2.7 million plus another $1.4 million of indirect expenditures. The majority of the change in expenditure as a result of declining fishing activity is occurring in Northeastern Ontario.[4]

	Annual Estimated Change in Expenditures	
	Direct ($000's)	Direct & Indirect ($000's)
Parry Sound, Muskoka and Haliburton	$ 824	$1,318
Acid Sensitive Eastern Ontario	-	-
Northeastern	1,859	2,788
Northwestern	-	-
Total Province	2,683	4,106

Eighty-three percent of these expenditures are made by provincial residents.[5] Thus most of these expenditures will not be lost

to Ontario, and will most likely be directed towards other types of recreational activities within the province. A transfer of these expenditures for rural to urban locations could take place thus having significant effects on some areas of the province. The non-resident expenditures particularly by residents of the United States will most likely be lost to Ontario as it is unlikely that American fishermen would be attracted for other activities. The 11% reduction in direct and indirect expenditures by Americans of approximately $450,000 would have a slight impact on Canada's balance of payments with the United States.[6]

2. Economic Effects on Other Activities Not Significant

The aquatic environment is also important for a wide range of other recreational activities. At current levels of acidification and based upon known physical effects, it appears unlikely that expenditures on other aquatic activities are now being reduced.

3. Effects From Fear of as Yet Unproved Effects Could Have a Large Impact on Recreation Activity

Throughout the case studies, cottagers, realtors, resort operators and others active in the tourist and recreation industry, expressed concern about the wide-spread publicity focussed on acidic precipitation. There is growing anxiety about the effects of this publicity on future business and the saleability of cottage properties. Press reports of damage to human eyes greatly concern people with businesses or other investments which could be affected. Some comments have been raised that current soft cottage markets in some parts of affected areas are the result of fear over acidification.

When the volatility of the recreation and tourist market is considered, it can be seen that damage to the image of vulnerable areas by negative publicity could have significant effects well

beyond those justified by current scientific research. In our view, fears concerning acidification particularly with respect to health are probably already having an impact.

Although current scientific research does not support the apparent level of anxiety, it is aggravated by the media and its effect cannot be discounted. The inability of individuals to tell from observation whether water is acidic or not only serves to encourage their concern. Over time, experience and evidence will remove poorly founded concerns but, over the short term, effects, though hard to predict, could be significant.

B. FUTURE LOSSES ARE LIKELY TO BE SIGNIFICANT

Losses in expenditures on fishing activity are anticipated to increase significantly under both the intermediate and worst case scenario of physical damages. At these levels, it is also likely that other aquatic-based tourist and recreation activities will be affected.

1. Annual Reduction in Fishing Expenditures Could Amount to $45 Million Annually

As indicated in Exhibit 11, the lost expenditures associated with decreased fishing activity will increase significantly under both the intermediate and worst case scenarios. Direct expenditures are estimated to be reduced by $13 million per annum under the intermediate scenario and by $45 million per annum in the worst case situation. When indirect expenditures are included in these estimates, the lost expenditures increase to $21[7] and $70[8] million per annum respectively. The extremely popular Parry Sound, Muskoka and Haliburton areas will account for the largest share of lost expenditure under either scenario.[9]

EXHIBIT 11

INTERMEDIATE SCENARIOS PRODUCE A POTENTIAL DECLINE IN FISHING-RELATED DIRECT EXPENDITURES OF $13 MILLION ANNUALLY*

	Annual Estimated Change	
	Angler Effort %	Direct Expenditures ($000's)
Parry Sound, Muskoka and Haliburton	-28%	$ 7,261
Acid Sensitive Eastern Ontario	- 2%	795
Northeastern	-11%	4,567
Northwestern	- 2%	734
Total Province	- 4%	13,357

...WHILE UNDER THE WORST CASE, REDUCTIONS IN DIRECT EXPENDITURE COULD RISE TO $45 MILLION ANNUALLY*

	Annual Estimated Change	
	Angler Effort %	Direct Expenditures ($000's)
Parry Sound, Muskoka and Haliburton	-82%	$21,191
Acid Sensitive Eastern Ontario	-12%	5,230
Northeastern	-29%	11,598
Northwestern	-16%	7,149
Total Province	-18%	45,168

* Source: Appendix VII, Exhibits VII-2 and VII-3.

Losses in the province's ability to produce sports fish in one area of the province cannot result in the transfer of this effort to other parts of the province because most of the province's sport fishery is harvested at levels which are not sustainable. Exceptions are non-road accessible areas of the province.[10]

The Great Lakes are also depleted of the more popular types of sport fish.[11]

Without increased management effort in areas not suffering from acidification, the fishing resource will not cope with this additional fishing pressure. Harvests will decline and, with them, declines in the efforts of anglers. As a result, these expenditures cannot be transferred to fishing activity elsewhere in the province. Most of the expenditure is likely to be redirected towards other recreation or tourism activities or to other types of expenditures.

The ability of an area to adjust to the loss in fishing activity will vary by Region and the nature of recreation and tourism in the Region. The relative importance of fishing to regions which have recreation and tourism appeal is a key factor in determining impact.

In areas of potential impact, south of North Bay, fishing is not of major importance because, generally, the quality of fishing is already low and users are less sensitive to further declines in the quality of the fishing experience. Commercial accommodations operators have already made the adjustment to lower quality fishing. Fishing is important primarily as a means of extending the season, particularly during the spring and fall when other activities are more limited. However, even in this area, there are exceptions where fishing is still of importance, for example, the Moon River area and Sturgeon Bay. These areas also appear to have a higher proportion of use by non-residents.[12]

In Northern Ontario, fishing is still sold extensively as it is the unique feature which attracts people to fishing lodges from long distances. Many of these operators will find it difficult to substitute other activities as there are numerous other areas closer to major urban markets which offer swimming, boating and relaxing in a natural environment.[13]

Response to changes in the quality of fishing is expected to vary by the type of user. Fishing is generally not a major factor contributing to cottage demand.[14] To cottagers other factors are more important, including: distance from home, extent of waterway, all season access, lack of weeds, local scenery, proximity to commercial services and the general prestige of the area. Impact would be most significant in a number of situations, including: small lakes where size of the water body limits the range of substitutable activities, lakes where fishing is currently of high quality, and instances where fishing contributes to spring and fall use of the water bodies. In addition, because of the capital investment, cottagers cannot easily respond to aquatic acidification.

As a result, it is unlikely that the demand for cottages will be influenced at early stages in the acidification process. Owners of cottages in the Sudbury area seem unconcerned about the lack of fish in the lake. However, if water contact activities are threatened, the demand for cottages could fall significantly.[15]

Fishing is only one of many factors contributing to camping activity.[16] As with cottages, there are localized cases where the impact would be expected to be great. These include campgrounds on small water bodies and on lakes where fishing is of high quality. Campers, unlike cottagers, can also respond to changes in the aquatic environment more easily as they have no capital investment in a specific location.

Non-residents of Ontario are likely to be more sensitive to declines in fishing quality. In Northern Ontario, fishing is the major reason for the use of non-urban commercial accommodation by Americans, 79%, as compared to 33% by Canadians.[17] In the near north, commercial operators report a decline in American tourists with the decline in fishing quality over the past twenty years because there are many other locations closer to the Americans' homes where aquatic activities other than good quality fishing can be enjoyed.[18]

Day-users are also likely to be more responsive to declines in the fishing quality or other changes to the aquatic environment as they have no firm commitments to any location and are flexible in choosing this destination.

2. Expenditures on Other Aquatic Activities Are Likely to be Affected by Increased Levels of Lake Acidity

Although clear, quantifiable links cannot be made between acidification of the aquatic environment and other aquatic-related activities, it is most likely that at the levels of acidification represented by the intermediate and worst case scenarios, other physical damages will occur. These damages are likely to result in significant reductions in expenditures for aquatic-based recreation and tourism activities. The key factor determining the level of future economic losses would be the impact on water contact activities. As waterfowl and moose hunting have more limited appeal, the economic consequences of a reduction in the physical base for these activities will be less significant.

a) If the Attractiveness of Water Contact Activities Were Affected, Potential Losses Would Increase Substantially

The water contact activities of swimming, boating, waterskiing and scuba diving account for over 68% of the

home based aquatic recreation activities and 71% of the overnight stays for aquatic recreation purposes.[19] In all areas except Northwestern Ontario, these activities contribute the majority of recreation and tourist expenditure. They are the main attraction for the summer tourist season throughout the Precambrian Shield area of Ontario.

Currently, evidence suggests that acidification may increase the attractiveness of water contact activities, as in circumstances where aquatic vegetation is reduced without introducing other effects. In these circumstances, the appearance of a lake could become more inviting to users. However, some research suggested that less attractive water quality may occur at various points in the acidification process and if such effects are persistent and widespread, the impact could be significant.

Water contact activities generate expenditures of about $300 million annually in the areas susceptible to acidification.[20]

	Water Contact As % of Total Aquatic Expenditures
Parry Sound, Muskoka, Haliburton	77%
Acid Sensitive Eastern	69%
Northeast	68%
Northwest	39%

In the Parry Sound, Muskoka and Haliburton areas widespread reductions in the attractiveness of water contact would destroy the recreation and tourist industry and the substantial investment in cottages and other facilities.

Before a definitive conclusion can be reached on the appropriate level of pollution abatement, more definite

conclusions on the effects of acidification on the physical appearance of waterbodies and damage to human health from water contact sports must be reached.

b) Effects on Waterfowl Impact Primarily Felt Outside Ontario

Much of Ontario's aquatic environment, susceptible to acidification, is an important waterfowl breeding ground. Small lakes and beaver ponds on the shield provide the most popular breeding locations in the potentially acid-sensitive portions of the province. As these water bodies are small, they are likely to be highly susceptible to acidification. With acidification, the food supply of many of the species common to Ontario will likely be affected. As a result, it is probable that populations of these species will be reduced if sizeable proportions of the province become acidified.

In terms of hunting, the most commonly hunted waterfowl species in Canada and the United States breed in Ontario. However, all of the major migratory waterfowl species that breed in Ontario are harvested more extensively in the United States than in Canada.[21]

	% of Total Kill By Major Species (Canada and U.S.) 1973-75	U.S. Share of Total Kill by Major Species
Mallard	33%	73%
Green-Winged Teal	12%	88%
Pintail	8%	85%
Canada Goose	7%	78%
Wood Duck	6%	91%
Blue-Winged Teal	5%	85%
Other	29%	75%
	100%	

Thus, most of the effects on recreational opportunities and expenditures for waterfowl hunting will likely be felt outside Ontario. Within Ontario most of the potential effects will likely be felt in non-acid sensitive parts of the province where 70% of waterfowl hunting occurs. Ontario hunters are limited by legislation to late migratory species, particularly the mallard, wood and black ducks.

Of the major species, those most affected will be the puddle ducks which include the two important species, mallard and black ducks. However, the lack of population data and a clear understanding of the relationship between breeding groups and hunting locations of these birds hampers quantification of the economic significance of these likely declines in hunting.

c) Moose hunting expenditures could also be reduced at increased levels of lake acidification

Currently direct expenditures on moose hunting in Ontario amount to $32 million annually.[22] This activity is an important means of extending the tourist and recreation season, particularly in Northwest and Northeastern Ontario. At increased levels of acidification, the moose population will likely be stressed by acidified key types of aquatic vegetation. This change in habitat conditions is likely to make the goal of increasing the moose population and, thus, hunting opportunities in Ontario more difficult. As a result, some of the economic benefits from an increase in moose hunting activity are likely to be foregone.

C. EXPENDITURES ARE AN INCOMPLETE MEASURE OF EFFECTS

The approach used in this study to determine the economic effect of changes in the availability of unpriced recreation resources is one focused on changes in expenditure. It can be argued that such an

approach underestimates economic impact because it ignores the value that consumers put on resources they do not directly pay for. Total benefits include consumer surplus which provides a measure of value for activities for which no direct charge is made.[23]

It should also be recognized that there are lost benefits when acidification occurs which cannot be measured by currently available economic tools. Such benefits include the contribution that the availability of lake-based recreation makes to the quality of life of those in urban centres who are not seen to make use of the opportunities. It is known from marketing practices that such perceived intangible benefits are significant enough to influence consumer purchasing patterns.

Currently quantifiable economic damages to Ontario's recreation and tourism industry are not extensive and primarily relate to localized reductions in fishing activity. It must be stressed that this conclusion is preliminary and much additional research needs to be undertaken before definitive conclusions can be drawn.

The potential clearly exists, however, for widespread damages in the future with attendant serious economic implications.

CHAPTER V

1 Appendix V, pp. 5-7.

2 Appendix VI discusses the selected case studies.

3 Appendix V, Exhibits V-7, V-8, V-9, V-10, V-11, V-12.

4 Appendix VII, Exhibit VII-1.

5 Calculated from Appendix VII, Exhibits VII-1 and VII-4.

6 Calculated by first estimating United States resident expenditures for fishing from Exhibits III-11 and III-17 in the two areas affected at present. Expenditures by United States residents are calculated on the basis of total occasions of U.S. day-use to total non-resident occasions. This ratio is then applied to non-resident day-use expenditures. Overnight stays are calculated in a similar manner. Next the estimated reductions in effort (Exhibit VII-1) are applied to the expenditure estimates. Finally, the multipliers contained in Exhibit III, p-6 are applied. This results in an estimate of $448,000.

7 Appendix VII, Exhibit VII-2.

8 Appendix VII, Exhibit VII-3.

9 Appendix VII, Exhibits VII-2 and VII-3.

10 Ontario Ministry of Natural Resources Crown Land Recreation Study - Phase 2, Toronto, March 1979.

11 Strategic Planning for Ontario Fisheries Work Group, Ontario Fish Yield Estimates, March 1979.

12 Appendix VI discusses these factors in more detail.

13 Ontario Ministry of Northern Affairs The Fishing and Hunting Lodge Industry in Northern Ontario, Toronto, January 1979.

14 This view was strongly expressed by real estate agents during case study interviews. Appendix VI discusses the relative importance of fishing to cottagers in various parts of Ontario.

15 Appendix VI, pp. 2-6.

16 Appendix VI, p. 17, discusses the activities participated in by campers at two of the province's major parks. The entire system shows somewhat the same pattern as documented in 1978 Provincial Park Camper Survey.

17 Ontario Ministry of Northern Affairs The Fishing and Hunting Lodge Industry in Northern Ontario, Toronto, January 1979, p. 18.

18 These views were expressed by several resort operators during the case studies.

19 Estimated from the Ontario Recreation Survey.

20 Appendix III, Exhibits III-11, III-14, III-17, and III-20.

21 Canadian Wildlife Service, Migratory Game Bird Hunters and Hunting in Canada, Report Series No. 43, estimated from "Distribution between Canada and the United States of Retrieved Waterfowl Kill by Sport Hunters", Table 1, p. 78.

22 Appendix III, p. 5.

23 Appendix VIII presents an attempt to measure these benefits using the theory of consumer surplus.

VI. FURTHER RESEARCH NECESSARY TO ESTIMATE COMPLETE ECONOMIC IMPLICATIONS

This assignment had two major objectives: to develop a framework so that additional economic evaluations can take place in the future, and to quantify, where possible, the effects of acidic precipitation on recreation and tourism. To meet these objectives, this assignment has focused on three major steps. First, links between acidic precipitation and the recreation and tourism resource base were established; secondly, the relationship between the resource base and recreation and tourism activities was established; and, finally, estimates were made of the economic importance and the potential losses from disruptions to these activities. Throughout this assignment, in each of these major tasks, lack of some data has limited our ability to reach conclusive findings. The key information missing is a lack of observed physical effects of the acidification of water bodies on the use patterns of fishermen and other users. However, an analytical framework has been developed and, as additional information and research findings become available, further analysis can be undertaken.

A. DEFINITIVE LINKS CANNOT BE MADE BETWEEN ACIDIC PRECIPITATION AND SOME COMPONENTS OF THE RESOURCE BASE AND HUMAN USEAGE

Of the three groups of activities which can be influenced by acidification, fishing, hunting waterfowl and moose, and water contact activities, fishing is the only activity for which quantifiable estimates of damage can be developed. Even with this activity only some of the damages can be quantified - reproductive failure.

Indirect links with hunting have also been identified through the animals' food supplies. Reductions could occur in both the moose and waterfowl population and, thus, a reduction in hunting opportunities could occur. However, it has not proven possible to measure accurately the extent of this potential decline.

Potential links with the water contact activities are also not understood. The greatest potential threat is reduced attractiveness for water contact due to changes in physical appearance of the water. Isolated or laboratory changes in clarity, colour and vegetation have been reported, but it is impossible to make generalizations about widespread effects to the physical appearance of Ontario's numerous shield lakes.

There is also lack of definitive understanding in predicting the outlook for future deposition and the effects of future acidic precipitation on the resource base. More extensive lake chemistry profiles would also be helpful.

Thus, eight areas should receive further investigation.

1. Forecasts of Future Acid Loadings Are Required
   Although future scenarios have been developed for this assignment, we do not know what scale of increased sulphur and nitrogen emissions, and over what time period, are required to produce this amount of acidification.

2. Effects of Acidic Precipitation on Watersheds
   At the present time, the relationship between the level of acidic precipitation on a geographic area and potential levels of watershed acidification are not clearly understood. Factors such as the size of the water body and size of the drainage area are key determinants of levels of acidity. The calibrated watershed studies currently underway will have to answer these questions.

3. Effects of Acidic Precipitation Over Time
   Longitudinal studies of acidification of water bodies do not exist. As a result, a clear understanding of the effects, on all aspects of the ecosystem, at various levels of acidification are not known. In addition, the ability of the environment to adapt (if at all) to various levels of acidity is not known.

4. Effects on Human Useage

Currently, it appears that the fear of perceived damages is likely having a greater impact on recreation and tourism than are actual physical damages. In order to dispell this fear and ensure that harmful effects will not occur to humans who have contact with these water bodies, definitive research needs to be completed. Particular attention needs to focus on the human eye and the likelihood of heavy metal contamination.

5. Additional Chemical Profiles of Lakes

Although the information on lake chemistry is fairly extensive, in some parts of the province, expansion of this data base would result in a more conclusive documentation of the extent of the potential acidification.

6. Changes to the Physical Characteristics of Water Bodies require further clarification. At present, the effects of various stages of acidification on water clarity, colour and vegetation is not clearly understood.

7. The Key Unknown for the Fishery is the Effect of the "Acid Pulse"

At present, neither its impact nor the probability of occurrence are well enough understood to make generalized conclusions.

8. The Effects on Waterfowl and Moose

Primarily, the ability of these species to find new habitats or to substitute food supplies is the key factor needing clarification.

B. RESPONSE OF USERS TO CHANGES IN THE RESOURCE BASE IS ALSO NOT WELL UNDERSTOOD

During this assignment, we have been able to develop a comprehensive recreation and tourist model which can develop a profile of the

various types of users by type of activity. Although numerous problems were encountered in developing this model, more serious problems occurred in making the links between changes in resource base and use.

The effects on the fishing component have been quantified by developing catch per unit effort functions for fishing which relate productivity to potential effort. Although case studies and other information suggest different responses by each of the different users, we have not been able to develop these relationships. The reaction of users to changes in the physical appearance of water bodies has also not been documented.

To overcome information gaps in this area, three areas should receive additional attention.

1. Need to Develop Demand Curves for Each of the Major User Types
   More studies such as the creel censuses undertaken by the Lakeshore Capacity Study Group need to be completed so that the relationship of the key user groups to the change in quality of the fishing resource can be developed.

2. Case Studies of Actual Response are required in predicting the response of anglers and other recreation seekers, particularly cottagers, to declines in the quality of fishing.

3. Use Data Should be Improved
   The Ontario Recreational Survey, which is one of the most comprehensive tourist and recreational data sources ever developed, is becoming out of date. Non-resident data are incomplete. The ability to use this information at a smaller scale regional level is required as the nature of the effects of acidification appear to be quite localized. The best means of improving this situation would be to undertake detailed surveys of recreational resource users in a number of sample areas in the province.

C. EXPENDITURES DATA USED TO ESTIMATE THE ECONOMIC VALUE COULD BE IMPROVED UPON

Much of the data used to estimate expenditures and, thus, the value of the various recreation and tourist activities is old and often incomplete. Additional surveys of expenditure patterns, the location of these expenditures and the response in expenditure patterns to changes in resource quality would further clarify this problem. Additional attention should also be directed towards developing more data so that the deficiencies in use of the expenditure approach can be overcome by use of alternative measurement techniques.

D. ANALYTICAL FRAMEWORK DEVELOPED CAN BE USED FOR FURTHER ANALYSIS

The analytical framework developed in this assignment can be used to analyse additional effects.[1] During the course of this assignment, a profile of aquatic-based recreation and tourism has been developed. This profile will allow additional links to be made between acidic precipitation and the key types of aquatic activities: swimming, boating, fishing, water skiing, scuba diving and waterfowl hunting. The framework will also allow for varying responses to acidification by different types of users, including:

- residents
- non-residents
- home-based
- overnight visitor including
  - cottager
  - camper
  - private home
  - other commercial accommodation

These divisions will be important as it is anticipated that the responses to additional acidification will vary by user group. In

addition, this profile of use by type of user will also allow for further refinement of the expenditure estimates as additional information becomes available.

In conclusion, some success has been achieved during this assignment in addressing each of the three major steps. Links have been made between acidic precipitation and fishing activity, and the potential links have been identified with other activities. User response to changes in the physical environment has also been identified for sports fishing and some indication of the responses in other areas has also been attained. Finally, estimates of the changes in expenditures for various aquatic activities have been documented. It is anticipated that the analytical framework developed in this document will be useful in further analysis as additional information on the effects of acidification of the aquatic resource base becomes available.

CHAPTER VI

1 Appendix IX discusses the framework and its weaknesses in more detail.

VII. CONCLUSION

This study should be considered as a first step in analyzing the complex implications for recreation and tourism of acidic precipitation. As such, this report has not reached definite conclusions on all aspects of the problem, and the evaluation is thus incomplete. However, the framework developed can be used to undertake further evaluations as more scientific information becomes available from further research.

In spite of numerous data weaknesses, it appears that current levels of acidity are having few quantifiable economic effects. The areas of current aquatic high levels of acidification are confined to the Sudbury and Killarney regions of the province and it is evident that fishing is the activity most influenced.

The future implications of increased levels of aquatic acidification are potentially severe as large portions of the province exhibit the physical characteristics of an environment which can easily acidify. However, the large amount of additional research that is required to confirm the future outlook suggests that it is not possible to reach firm conclusions at this time.

We have enjoyed the challenge of this assignment and appreciate the time and assistance which many individuals throughout various government agencies and elsewhere have given us. We are hopeful that this document will serve as a useful foundation for a greater understanding of this complex problem which is currently facing Ontario.

Yours sincerely,

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